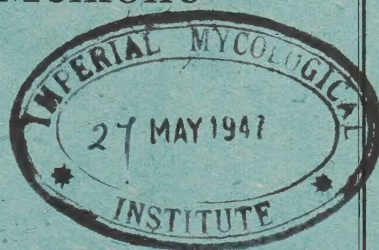


University of Cambridge
School of Agriculture Memoirs



Memoir No. 18

A summary of the papers published by the members of the Staff of the School of Agriculture and its Associated Research Institutes during the period Oct. 1st, 1945—Sept. 30th, 1946.



CAMBRIDGE
1947

FOREWORD

This Memoir, which is published under the general editorship of the Librarian of the School, represents an attempt to present as succinctly as possible the contributions made by members of the Staffs of the School of Agriculture and its Associated Institutes to the development and progress of Agricultural Science, to indicate to research workers interested the Journals in which the full papers are presented and to act as a complete record of papers published. Each summary is compiled by the author of the paper and is presented, so far as the subject matter will allow, in a non-technical form in order to be of value to the general body of farmers interested in the more recent developments of agricultural scientific research in general and of the activities of this Department in particular.

Requests for further information or criticism arising out of the summaries should be referred to the individual author concerned, criticisms and suggestions for the improvement of the Memoir itself should be addressed to the Librarian of the School.

It is to be regretted that owing to shortage of paper only a very limited number of reprints are available.

The Librarian takes this opportunity of thanking all Institutions etc. who have kindly sent literature during the past year.

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THE SCHOOL OF AGRICULTURE INCLUDING ESTATE MANAGEMENT, THE ADVISORY SERVICES AND ASSOCIATED RESEARCH INSTITUTES

Agricultural Education in Cambridge dates from 1892 when the Cambridge and Counties Agricultural Education Committee, an informal body consisting of University Professors and County Council representatives, first organized an Agricultural Course. In 1899 the University created a Department of Agriculture to take over the work of this Committee. The School of Agriculture was built by public subscription in 1909 and expanded by a grant from the Development Commission in 1912. The rapid expansion of the Animal Nutrition Institute and the Plant Breeding Institute under the direction of Professor T. B. Wood and Professor R. H. Biffen led to increased demands on accommodation, and an extension to the building was made in 1925-26 by the aid of a further grant from the Development Commission. The Estate Management Branch was established to provide technical and professional assistance in the management of University and College property and has now become a separate Department under the Board of Estate Management.

The Rockefeller Benefaction, made to the University in 1929, provided money for additional accommodation for the Department of Agriculture and for an expansion of its activities, and a new building was completed and occupied in March, 1933.

The Department of Agriculture is a teaching department of the University and offers a course of instruction leading to a degree and separate courses leading to graduate diplomas in Agriculture and Agricultural Science. Research in the problems of agriculture and cognate sciences is carried out by members of the teaching staff and by members of the staffs of the Research Institutes attached to the Department. During the period covered by this issue of the Memoir, a number of advisory officers were available to give specialist assistance and advice to farmers on their problems. With the exception of the Provincial Economics Advisory Staff these officers have now been transferred to the National Agricultural Advisory Service. Additional facilities for both teaching and research are provided by the University Farm which occupies an area of some 700 acres within reasonable distance of the scientific laboratories.



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RESEARCHES IN THE PHYSIOLOGY OF REPRODUCTION DONE IN CAMBRIDGE : A BRIEF HISTORY.*

By

F. H. A. MARSHALL, C.B.E., Sc.D., F.R.S.

(*Emeritus Reader in Agricultural Physiology*)

At the beginning of the present century our knowledge of the physiology of reproduction, both in man and in animals, was slight. This ignorance was shown in the standard text-books in which the subject of reproduction was either omitted altogether or relegated to a few final pages seldom free from error. It was reflected also in the regular university lectures and here in Cambridge instruction on sexual physiology was relegated to about half a lecture given by the lecturer on the special sense organs at the end of the course on his own subject. In other countries the state of sexual physiology was hardly, if any, more advanced. In Germany and Austria it was left almost entirely to the gynaecologists among whom Knauer, Halban and more notably Fraenkel performed experiments on ovarian activity. In France Bouin and Ancel did similar work in the first decade of the century. In the United States Oscar Riddle was practically alone as a sexual biologist but his outstanding experiments on sexual changes in birds soon brought him into prominence. The only other investigators of any note were the brothers Loeb whose work on the nature of fertilisation and on one of the ovarian functions brought them contemporary distinction. In this country the potential importance of the physiology of animal breeding was fully realised by Walter Heape, who stood almost alone but whose memoir on the sexual season formed the basis for much later research, though his own work and training were almost entirely those of a morphologist; nevertheless, he had a knowledge of farm animals and a real acquaintance with the commercial problems of the practical breeder with whose difficulties he had a genuine sympathy. The above remarks apply to the study of the physiology of reproduction in the strict sense; they do not relate to the all-important subjects of heredity, which although intimately connected with the study of generation, are separate subjects in themselves and were in active progress at the beginning of the century in Edinburgh under the direction of Cossar Ewart, and in Cambridge under that of William Bateson who in common with other contemporary investigators realised the importance of the re-discovery of Mendel's laws and the possibility of applying these to the domestic animals with great advantage to the practical breeder.

The entire trend of physiological research some forty years ago and also subsequently was to show that the correlation that exists even between remote parts of the body is often extraordinarily close and that there is not an organ or structure that is not dependent in its growth and activity upon chemical substances elaborated by other and sometimes distant parts of the body and carried thence in the circulating blood. Thus a change in the whole metabolism producing palpable modification in whole groups of characters might be induced experimentally in the individual by interfering with or removing one particular organ. This is well shown in the various kinds of correlation existing between the organs of internal secretion and notably, among others, by the generative glands. Some of the earliest work on this particular subject was done early in the century at Edinburgh where, in addition to extending and working out in some detail the changes which occurred in the reproductive organs of the sheep, the ferret and the dog, pioneer researches were done on the endocrine activities of the ovary and the correlations of the ovarian and uterine functions. In particular, it was shown that the chief successive phases of the sexual or oestrous cycle, as described by Heape, were almost entirely dominated by internal secretions or hormones elaborated in varying amounts at different seasons by distinctive parts of the female reproductive organs.

In 1908 a university lectureship in agricultural physiology was founded in Cambridge and in connection with this appointment and in addition to the teaching duties assigned to it, an attempt was soon made to transfer the work begun in Edinburgh to a centre at which it was intended to supply improved facilities for breeding domestic animals for purposes of experiment. Land was acquired by the side of the Ely road leading out of Cambridge and the work on it was administered by a committee on which the departments of physiology, pathology and parasitology were also represented, and this land was licensed for purposes of experiments on animals. Some of the larger farm animals were kept and investigations on their physiology were begun. Some of the animals on the University Farm were also made use of, and small animals such as rabbits, rats and ferrets, on which it was convenient to work out some of the reproductive processes, were maintained in the animal rooms of the laboratory buildings of the university.

Among the earlier work done on farm animals was that on fatness as a cause of sterility. It was known that an excessive quantity of nutriment was prejudicial to the proper discharge of the reproductive functions. The barren Shire mares which were a striking feature at agricultural shows afforded a well known example. Sugar, molasses and linseed were noted for having a similar effect upon cattle, but they were often used to prepare beasts for show or sale, since they produced a good coat of hair and caused a deposit of fat. It was known that very fat animals did not come in season so often and moreover, cattle tended to settle better and feed faster when they were undisturbed by sexual excitement and they the more readily became what the butchers designated as 'fat ripe'. The Cambridge enquiries investigated the physiological condition of the breeding organs of such animals and revealed the reasons why they were unable to breed, thus confirming the experience of those practical farmers who deprecated the practice of undue fattening. Among other points of interest it was found that the ovaries of fat cows and heifers often contained in their interstitial tissue large quantities of a bright orange-coloured lipochrome. On the other hand, an abnormally low condition as in the case of cattle wintered in the open air or of cows which have suckled a large calf or more than one calf, might also be a cause of temporary sterility. In general, for all animals a nice improving condition, not too fat nor too lean, was most conducive to normal ovarian activity and consequently to fertility (Marshall and Peel, 1910).

* This is the first of a series of articles summarizing phases of agricultural research particularly associated with the School of Agriculture since its inception. Further contributions on other work will appear in future issues.

About the same time pioneer work was done on the functions of the male organs, both testicles and accessory glands, and on the male reproductive cycle. In working out the series of cyclical changes the hedgehog, in which the seasonally recurrent changes are very marked, was taken as a type and important information was obtained as to the functions of the various organs and the essential part taken by the testes in controlling the processes which occurred (Marshall, 1911). The endocrine functions of the testes were also investigated in sheep, the Herdwick breed being used, as in these sheep the rams only are horned and the skulls of the wethers resemble those of the ewes. In this breed it was shown that not only is the presence of the testes necessary for the initiation of horn growth but for its continuance, the horns ceasing to grow forthwith after castration and at any stage of horn development. Furthermore, unilateral castration did not inhibit the growth of the horns which developed symmetrically in the usual manner, contrary to what had been said about the antlers of partially castrated stags (Marshall & Hammond, 1914).

Knowledge gained from a study of the smaller animals was also applied and extended to pigs. The practice of spaying (ovariotomy) or the removal of the ovaries of sows, was carried out in many districts in cases where the animals were not required for breeding, for it was realised that such animals are undisturbed by the recurrence of heat periods which cause restlessness and loss of energy during what should be the time of fattening. Spaying has the further advantage that it prevents the growth and extension of the mammary glands in which, in certain breeds, black pigment is commonly found giving rise to the disfiguring condition due to the so-called "seedy-cut". This is a black speckling in the belly of the carcass which is objected to by the bacon manufacturer and by the consumer on account of its appearance, notwithstanding that the pigment is perfectly harmless, being identical with the pigment of the skin. In spaying sows the usual practice is to remove the uterus (womb or bed) along with the ovaries and oviducts, and in printed instructions formerly issued by bacon manufacturers it was stated that it was important to withdraw the bed entire. This was a mistaken idea for experiments upon small mammals as well as on pigs have shown conclusively that the extirpation of the ovaries is the only essential part of the operation of ovariectomy, the removal of the uterus being merely a matter of convenience. It used sometimes to happen, however, that one ovary was left behind accidentally at the time of spaying (the ovaries being very minute at the age of six or seven weeks) and when this happened the sow behaved as though she had not been operated on and came on heat like a normal "open" sow; such occurrences had tended to discredit spaying in some areas. The complete removal of both ovaries is, however, necessary to de-sex the sow completely, just as is the case with all other animals, and if done early enough the accessory genital organs and mammary glands do not develop (K. J. J. Mackenzie and Marshall, 1912-13-14).

Of the investigations, already alluded to, on the smaller animals, by far the most complete were those of Dr. John Hammond on "Reproduction in the Rabbit", whose memoir (1925) with that title embodied most of his investigations on that animal together with those of Heape and Marshall, some of which were done at an earlier period. The changes occurring in the whole oestrous cycle were fully worked out and described, and among other facts it was shown or confirmed that the rabbit, like the ferret, required the stimulus of coition, or at any rate some specially applied sexual stimulus, to induce the ovarian follicles to discharge the ova. Hammond showed further as a result of his experiments that in the rabbit the ovum is capable of being fertilised after it has been shed for not more than four hours, and that spermatozoa must be present in the female tract ready to meet the ovum as it passes to the Fallopian tubes or oviducts in order that the process of fertilisation may be accomplished. It was shown further that the spermatozoa can only live in the female and be capable of fertilising for about thirty hours but that in the male they may survive inside the generative passages for about thirty-eight days. These results were afterwards confirmed and extended in the case of the larger farm animals on which Hammond also worked.

The memoir on 'The Physiology of Reproduction in the Cow' (Hammond, 1927) was very complete and embodied a number of new observations, not only on the sexual organs but also on the udder. Among many other matters of interest the time relations between oestrus and ovulation were determined. It was shown that ovulation occurs between thirty and forty-eight hours after the beginning of heat and that bleeding from the vulva takes place in most heifers but in few cows forty-eight to seventy-two hours after the beginning of heat. Ovulation very often was found to occur after heat was over. These are points of practical interest in connexion with the service of cows. It was shown further that removal of the corpus luteum (which is formed from the discharged ovarian follicle) performed six days after the previous heat results in the return of heat within two days, so that there is an oestrous cycle of two hundred hours instead of a normal one of four hundred and fifty hours; thus the corpus luteum controls the duration of the short oestrous cycle. Furthermore, not only does the removal of the corpus luteum shorten the length of the cycle but it was also found to shorten the length of the subsequent heat period so that after the operation a heat period of eleven hours ensues instead of a normal oestrus of twenty-one hours. This observation is of fundamental importance in relation to the cause of oestrus. Normally it was found that in the cows observed there was a correlation between the length of the cycle and the length of oestrus. In order to determine the respective durations Hammond made use of a vasectomised bull, that is, one in which the vasa deferentia or ducts leading from the testes were severed, so that the animal was sterile though fully capable of performing service.

Work had already been done on the post-oestrous changes occurring in the generative organs of the non-pregnant bitch (Marshall and E. T. Halnan, 1917) in which it was shown that the uterus and mammary glands undergo pronounced post-oestrous development under the influence of the corpora lutea, there being a definite pseudo-pregnant period. The corpora lutea in this animal persist for as long a time in the absence of pregnancy as they do in the pregnant animal and this is apparently correlated with the fact that bitches are monoestrous having only a single heat period in a season and not experiencing a succession of short cycles such as are seen in the cow, the sheep, the sow and the mare. Under the influence of these corpora lutea not only the uterus but also the mammary glands develop and the latter often secrete milk at the end of the pseudo-pregnant period just as though they had young to suckle. The persistence of the corpora lutea and their eventual regression

also account for some individuals preparing a bed at the end of pseudo-pregnancy as though for the reception of pups which are not there. The general type of change is strictly comparable to what Hammond found in the pseudo-pregnant rabbit, but in that animal the phenomena usually only occur in animals which had copulated with a vasectomised and so sterilised buck.

With the bitch as with the sheep and indeed most animals, which often or usually have more than one young in a litter, the number born depends mainly on the number of ova which are shed by the ovaries at the periods of oestrus. In the sheep it had been shown that by the practice of 'flushing' or feeding the ewes liberally upon additional stimulating foods at the approach of the tupping time, the number of ovarian follicles which ripen at a time could be increased and consequently the percentage of lambs born could also be increased. The sow, however, differs from the ewe in that the size of the litter depends less upon the number of ripe ova and much more upon the number of embryo pigs which survive in the uterus so as eventually to be born. The subject has been investigated by Hammond (1914, 1928) who showed that foetal degeneration is not due to bacterial infection since it commonly occurs in sows in which the uterus is entirely aseptic. And it does not result from overcrowding since the uterus is an organ with great powers of distension, and the degeneration may take place in organs that contain relatively few foetuses; moreover, several dead foetuses may be situated near one another in one part of the uterus, while another part may be full of living piglings. When the number of ova shed at oestrus is greater than the average, the number of atrophic foetuses is also greater. It is probable that nutrition plays some part in determining the degrees of development that the foetuses reach and also the size of the foetuses, and it is noteworthy that atrophy may occur at all stages of development and that some piglings, though they are duly delivered at the end of pregnancy, yet are much below the normal size and often perish soon after birth. Hammond compared the results with what he observed in some strains of rabbits in which foetal atrophy was found to be a recessive genetic character, and he remarked that since pigs are peculiarly susceptible to the ill effects of inbreeding, it is probable that in this animal, as in the rabbit, the death of the foetuses in the uterus may result partly from an accumulation of lethal or other detrimental genetic factors. Hammond has also obtained evidence that low fertility in pigs may be due to an insufficiency of spermatozoa from the boar for the number of ova shed by the sow (as shown by the number of corpora lutea or discharged follicles in the ovaries) may considerably exceed the number of foetuses, both alive and dead, in the uterus. In support of this conclusion cases have been described in which sows which produced large litters when mated with one boar, gave only small ones when mated to another boar. Furthermore, mating is a long process in pigs, sometimes taking twenty-five minutes, and any disturbance may result in an insufficiency of sperm ejaculation.

Among other work carried out at the School at the beginning of the succeeding decade was that on the external factors involved in bringing animals into breeding condition and eventually causing them to come on heat. It had been long known that nutrition and a due degree of warmth, varying for different species, were necessary factors or conditions but neither special food nor any particular temperature appeared to have any direct effect on the organs of reproduction or upon the oestrous cycle. Light and ultra-violet irradiation, on the other hand, had a direct influence. Thus Professor T. H. Bissonette (1932) who came as a research visitor from the United States, showed that ferrets could be brought fully on heat and induced to breed in mid-winter, when they are normally anoestrous, by exposing them to artificial illumination by electricity for a couple of hours or so at the end of each day, thus extending the period of light to a duration comparable to that which they normally experience in the spring. A later investigation (Marshall 1940) showed that with female ferrets subjected to different degrees of light intensity, as measured by putting them at different distances from a 1000 Watt lamp, the acceleration of the oestrous cycle was roughly correlated with the degree of intensity. Moreover, feeding vitamin D or any other special feeding did not result in accelerating the cycle, the animals not coming on heat until the usual time. A large body of experimental and observational evidence in other places has shown that a very considerable number of vertebrate animals react similarly to light (but not ruminants) and the practice adopted by the poultry industry of subjecting hens to artificial illumination in order to promote egg-laying is probably an application of the same principle. The actual paths of transmission of the stimuli in ferrets have since been investigated elsewhere and it has been shown that if the optic nerves are severed the response to extra lighting does not occur. Moreover, it would seem certain that the stimulus passes to a centre in the brain and thence to the anterior pituitary gland, a small organ underneath the brain, which elaborates internal secretions that act upon the testis and the ovary.

Among the earliest evidence that some such organ as the anterior pituitary produced a substance acting on the ovary was that of Asdell (1924), at that time a research student working in the School. He showed that the number of eggs ripened by an animal must depend on some substance circulating in the blood and not upon the structure of the ovary, for when one ovary was removed approximately the same number of eggs were shed as in an animal with two ovaries. Moreover, in an ovary removed from the normal position and transplanted to an abnormal one, such as the ventral wall of the body cavity, in a rabbit after the sexual stimulus of copulation, such an ovary would discharge its eggs as in ordinary ovulation from the normal position. The presumption was, therefore, that the stimulus bringing about the discharge came from a substance circulating in the blood as a result of activation of some organ of internal secretion consequent upon copulation.

The substances in question were found by workers in U.S.A. and Germany to be formed by the anterior pituitary, and a substance with the same effects was obtained from the blood serum of mares at certain stages of pregnancy. Experiments by J. Hammond, jun. and P. Bhattacharya (1944) done in Cambridge have since shown that these substances if injected into cattle a few days before service may cause the animals to produce twins or triplets according to the amounts injected. They may be used also to make sheep breed out of season and to have three crops of lambs in two years, and to make goats have kids in the autumn and thus add to the winter milk supplies.

The question as to the nature of the stimuli which activated the anterior pituitary was also investigated in Cambridge by Marshall in association with Dr. E. B. Verney of the Pharmacology Department (1936).

They found that stimulation of the brain or spinal cord of the rabbit caused the ovarian follicles to rupture and this result could also be induced by certain drugs which were known to stimulate the central nervous system, and general evidence was obtained showing conclusively the paths through which the external stimuli passed in order to reach the sexual organs and so induce heat and promote reproduction. Dr. G. W. Harris (1936, 1941), a former student of Dr. Marshall's but later in the Anatomy Department, obtained further evidence demonstrating the existence of a definite centre in the ventral part of the brain and controlling the functions of the pituitary.

The study of male fertility has been the subject of study in the School since about 1922 when Dr. Walton began his long series of experiments and observations on spermatozoa kept outside the body, and the respiratory processes and the optimum temperature for preserving the sperms alive were investigated (1930). This subject is of great importance in connexion with the practice of artificial insemination. Long distance transport of semen was achieved in 1927 when Walton sent rabbit spermatozoa to Edinburgh where they were successfully used to impregnate does by Professor F. A. E. Crew. Subsequently Walton and R. Prawochenski (1936) sent living ram semen to Poland and J. Edwards, A. Walton and F. Siebenga (1937) sent bull semen to Holland and the sperms so dispatched were afterwards successfully used. An important application of the technique of artificial insemination consists of its use in impregnating large numbers of females with the spermatozoa obtained from one specially selected male, e.g. a bull whose genetic value as belonging to a milk-producing strain had already been proved.

Comparable work on the reproductive products of the female mammal was begun here by Professor G. Pincus (1930) who was a National Research Council Fellow from Harvard, U.S.A. Pincus successfully cultivated the fertilised eggs of the rabbit outside the body and afterwards transplanted them into other individuals. He made use of anterior pituitary secretions such as that referred to above and was able to obtain fifty or more eggs at a time. The experiments, however, were only in the initial stage and have not yet been extended to farm animals.

Numerous studies of milk secretion and the growth of the mammary glands which are so closely correlated with the female reproductive organs, have also been carried on or in connexion with the School. Dr. H. G. Sanders (1928) carried out a statistical investigation of the factors affecting milk yields and this enabled 'correction factors' for age, dry period, service period, etc. to be determined. Hammond (1927) showed that in heifers in calf for the first time a sudden increase in the growth of the milk-secreting tissues occurred at the twentieth week of pregnancy. L. R. Wallace (1944) found that this growth could be increased considerably by a high level of feeding in the later stages. The chemical stimulus for growth was produced by substances (oestrogens) formed in the placenta and secreted into the blood, and J. Hammond, jun. and F. T. Day (1944) using these substances, obtained a growth of the udder and milk yields of up to 30 lbs. a day with a normal lactation period in heifers which had never been pregnant. They used the method of tablet implantation which was developed in the laboratory at the National Institute for Medical Research by Dr. A. S. Parkes, who was formerly a student of the School of Agriculture.

Further studies on the effects of a high plane of nutrition in the later stages of pregnancy in increasing the weight and vigour of lambs at birth were carried out by Hammond (1932), J. B. Verges (1939) and by L. R. Wallace (1944), and these have suggested a remedy for the large losses that occur at or shortly after lambing owing to the birth of weak or ill-developed lambs.

Experiments with rabbits had shown that the weight of the individual young tended to decrease as the number of young in the litter increased, and this was evidence of an effect produced by the nutritional environment of the mother. To test this supposition further Walton and Hammond (1938) made reciprocal crosses between Shire horses and Shetland ponies, which differ very greatly in size, and found that the mother produced a marked influence other than a genetic one, not only on the birth weight of the foal, but also on the ultimate size to which the crosses attained.

The work on the inheritance of meat qualities belongs more properly to the study of animal nutrition or to genetics than to the physiology of reproduction, but since it was done in association with some of the researches described and often by the same investigators, it has been thought appropriate to make some reference to it before concluding this article. The experiments by the late K. J. J. Mackenzie and Marshall (1917) on the inheritance of mutton qualities in crosses between Merino and Shropshire sheep had shown the necessity for more accurate definitions and descriptions of such qualities before real progress could be made in breeding for specific meat characteristics. In order to obtain such a knowledge an elaborate joint investigation by the late P. G. Bailey, a geneticist, Dr. A. B. Appleton, from the department of Anatomy, and Hammond, was undertaken and the results were published in a book by Hammond (1932), the whole constituting an account of the scientific principles which form the basis of meat production. Later analytical studies of the meat qualities of cattle, sheep and pigs of different breeds were carried out by R. Hirzel (1936), Hammond and G. N. Murray (1937) and H. Palsson (1940), and experiments on the effects of nutritional level during growth on pigs and sheep were done by C. P. McMeekan (1938) and J. B. Verges (1939).

References to the papers quoted above may be found in the following works:—

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AGRICULTURAL ECONOMICS

Threshing by British and American Machines.

Fm. Econ. Br. Fmrs' Bull. No. 10, 1946. Pp. 16. Price 2s.

An investigation into the economics of threshing wheat and barley was carried out in the Eastern Counties of England. The more important conclusions were as follows:—

1. A comparison of British and American (farmer-owned) threshing machines showed that the cost of threshing per quarter was as follows:—

Cost per Quarter:—					British	American
Wheat	...	...	...	...	4/11	2/8
Barley	...	...	...	...	3/8	2/1

The lower costs for American machines were due partly to a higher throughput and partly to lower operating costs.

2. With labour saving devices such as the conveyor feeder, band cutter and straw and chaff blowers, the American machines required on the average only five men, compared with nine or ten on British machines. The use of straw and chaff blowers, however, introduces certain technical difficulties which are discussed in detail.

3. The average cost per quarter of contractor-hired British machines was as follows:—

Wheat	...	...	...	...	6/-
Barley	...	...	...	...	5/10

The throughput per day was greater than with farmer-owned machines—particularly when the machine and gang were hired on a piece work basis—but this was insufficient to compensate for the higher cost per day. The cost per quarter was therefore greater than for farmer-owned machines.

4. An examination of the records of throughput per hour showed that while considerable variation occurred in individual cases, the majority ranged from 40 to 70 quarters per day. On the whole, the throughput of barley is greater than that of wheat. A high throughput per hour is also associated with a high yield per acre and a high ratio of grain to straw.

For this reason a more accurate means of measuring the capacity of a threshing machine is the volume of unthreshed straw passed through rather than the weight of grain threshed.

5. A number of suggestions are made whereby the British type of threshing machine might be improved to reduce the labour requirements and the cost of operation.

841* MENZIES-KITCHIN, A. W. & CHAPMAN, W. D.

War-time Changes in the Organisation of Two Groups of Eastern Counties Farms.

Econ. J. 1946, 56, 57–85.

This investigation examines the changes, both physical and monetary, which have occurred in two groups of twenty-five identical farms on the central Norfolk loams and on the south Essex London clays, between 1933 and 1943. It also attempts to estimate their probable financial position if the system of farming followed in each of the war years had operated at 1938 levels of prices and costs: in other words, whether the farmers concerned would have been better off in 1938 if they had farmed their land as they did in, say 1940, 1942, or 1943.

In central Norfolk gross income per 100 acres rose from £878 in 1938 to a maximum of £1,802 in 1942, and then fell to £1,540 in 1943, the fall in the latter year being mainly due to the reduction in barley prices. Between 1938 and 1943 the percentage of gross income derived from crops rose from 43.1% to 56.5%, while the proportion from livestock fell from 58.8% to 42.7%. In 1943 wheat actually provided a smaller percentage of gross income than in 1938—13.6% compared with 15.8%, but the percentage of income derived from barley had risen from 16.7% to 30.4%. A slight increase occurred in the proportion of income derived from milk.

In south Essex the gross income per 100 acres rose steadily from £941 in 1938 to £1,664 in 1943. Over the same period the proportion derived from livestock and livestock products fell from 80.1% to 50.6%, while that derived from crops rose from 18.0% to 46.4%.

Substantial alterations to the distribution of expenditure occurred in both districts. Labour as a percentage of total expenses rose in central Norfolk from 34.9% in 1938 to 43.2% in 1943, while in south Essex it increased from 25.9% to 33%. The percentage of income spent on fertilisers increased in both areas, but the percentage on purchased feeding-stuffs fell in central Norfolk from 13.7% in 1933 to 6.2% in 1943, and in south Essex from 26.6% to 9.4% over the same period. Rent as a percentage of total expenditure also declined in both districts. In central Norfolk expenditure as a whole increased from £790 in 1938 to a maximum of £1,116 in 1942. Between 1942 and 1943 it fell from £1,116 to £1,062, the fall in the latter year being mainly due to smaller purchases of feeding-stuffs and of livestock. In south Essex expenditure per 100 acres rose steadily from £829 in 1938 to £1,203 in 1943. After 1940 reductions occurred in expenditure of purchased feeding-stuffs, which fell from £256 in 1940 to £113 in 1943. Expenditure on fertilisers, on the other hand, increased from £27 in 1938 to £76 in 1943.

When war-time production was adjusted to 1938 prices and costs the results were less spectacular. In central Norfolk gross income (£878 in 1938) was £924 in 1939, £868 in 1940, £904 in 1941, £918 in 1942 and £817 in 1943. In the same years gross income in south Essex (£941 in 1938) was £1,066, £955, £911, £957 and £948 respectively.

Income and expenditure adjusted to 1938 prices and costs indicate the changes in physical terms which have occurred in production and requirements. Comparing 1943 and 1938, it will be seen that quantitatively the amount of wheat sold on the central Norfolk farms was less in 1943 than in 1938, but sales of barley increased by roughly 11%. Milk output increased by 12%, but sales of other cattle were halved, while pig sales were quartered. Comparing gross income in 1938 and 1943, the income from crops was roughly the same in both years—£379 in 1938 and £384 in 1943—but the income from livestock had fallen from £489 to £424. In terms of requirements slightly less labour per 100 acres was used in central Norfolk in 1943 than in 1938, purchases of fertilisers increased by 50%, while purchases of feeding-stuffs and livestock were halved.

In south Essex gross income calculated at 1938 prices revealed that in physical terms, wheat production had been more than doubled, barley production increased more than four times, sugar-beet and potatoes increased two and a half and four times respectively, while the production of market-garden crops had increased threefold. On the other hand, milk production, which in 1938 represented 55% of the gross income, fell by 31%, and the production of pigs 92%. On the requirements side 5% more labour was employed, and purchased concentrates fell by 60%.

When income and expenditure were re-calculated at 1938 levels of prices and costs, there was little change in gross output in central Norfolk between 1938 and 1943, and no significant increase in the value of output per man. In south Essex a slight rise occurred in both gross output and gross output per man.

Actual farm incomes per 100 acres in central Norfolk and in south Essex increased from £88 and £112 respectively in 1938 to £478 and £461 respectively in 1943: re-calculated at 1938 prices, however, they rose only from £88 to £135 in central Norfolk and from £112 to £186 in south Essex. Taken in conjunction with Table XX, which shows the amount of subsidy included in 1938 prices in each year, it is evident that while the war-time organisation in central Norfolk has slightly lessened the dependence of the area on subsidised crops, the reverse has occurred in south Essex, where the farm income in 1943 calculated at 1938 levels of prices and costs contains £149 in subsidy payments, compared with £67 in 1938. Nevertheless, even in south Essex, farm incomes excluding subsidy re-calculated at 1938 prices would have been higher than they were in 1938 in every war year except 1943. Further, as in south Essex the increase in subsidy payment on this re-calculated income was mainly due to the support, roughly 20s. a quarter, required to maintain an average price of 45s. a quarter for wheat, the amount of subsidy would decrease sharply with a rise in world wheat prices above the low prices of 1938.

In both districts the social output derived from the 1943 organisation calculated at 1938 prices and costs would have been higher than that of the 1938 organisation, and this would have been so even when subsidies were excluded from farm income. In south Essex, however, the increase in social income after omission of subsidies would have been only £5 per 100 acres, compared with £52 per 100 acres in central Norfolk.

Farm Economics Branch War Series Reports.*

- No. 30. Further Wartime Changes in Milk Production. (Appendix Comparing the Years, 1942–43, 1943–44 and 1944–45 for attachment to War Series Report No. 30.)
 No. 31. An Investigation into the Cost of Growing Barley in North-west Norfolk and South-east Cambridge-shire, 1944–5.
 No. 32. An Investigation into the Cost of Growing Potatoes in East Norfolk and the Holland Division of Lincolnshire, 1944–5.

* Obtainable from the Farm Economics Branch.

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AGRICULTURAL ENGINEERING

- BROOKES, A. J.
Farming Equipment.
 Pp. xii + 152. Pitman, 1946. Price 6s.

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Farm Buildings and Milk Production.
 Contribution to Winchester Conference on *Mechanization of Milk Production*, pp. 1–18. H.M.S.O., 1946. Price 2s.

AGRICULTURAL ZOOLOGY (including Entomology)

- 819* JONES, F. G. W.
Soil Populations of Beet Eelworm (*Heterodera schachtii* Schm.) in Relation to Cropping.
Ann. Appl. Biol. 1945, **32**, 351–80.

Between 1934 and 1936 beet eelworm was found to be prevalent on a farm in the Isle of Ely. The virtual absence of other species of *Heterodera* and the workable nature of the soil made the farm ideal for the study of soil populations. In 1937 a sampling technique for estimating the cyst, viable cyst and egg content of soil was developed and standardized. The first part of the paper deals with the sampling technique and investigation of the various steps of which it is composed. When put into operation, the technique gave consistent results, but difficulty was experienced with counts of viable cysts and eggs owing to bias between different observers.

The second part of the paper gives the results obtained by the application of the technique to twenty-four fields during the period 1937-42. There appears to be a correlation between the general level of the eelworm population and the frequency with which susceptible crops are grown, and also between the general level of the population and the amount of damage to the crop, 'beet sickness' being most extensive and most severe where populations are greatest. Marked increases in the eelworm population follow the planting of susceptible crops upon heavily infested land, while smaller increases occur in fields with low eelworm populations. Fields which were completely 'beet sick' required very long periods of rest from susceptible crops (more than 10 years) before the eelworm populations in them fell to a low level and before they could be regarded as safe to grow sugar beet once more. The general effect of non-susceptible root crops is to bring about a lowering of the eelworm population. Cereals have the same general effect, but to a lesser extent. In some instances, rises were recorded after the growing of cereals. These appeared to be due to weeds, or to susceptible crops growing as weeds amongst the cereal crops. Claying had a beneficial effect.

The results of the investigation indicate the difficulties which may arise where close cropping is practised with crops susceptible to eelworm, and the desirability of avoiding widespread 'beet sickness' in important beet-growing areas. Brassicae are capable of increasing beet-eelworm populations, although they do not as a rule show signs of distress when growing on land where sugar beet develops the symptoms of 'sickness'.

A strong correlation was observed between the viable cyst and egg content of bulk samples. This suggests that viable cysts are a better measure of the general level of the eelworm population than might have been supposed. Cysts decay slowly and remain in the soil long after they are devoid of living contents. For this reason cysts alone are better as a guide to the past history of an infestation than as a measure of its present intensity. The eelworm population of any field is complex and has highly individual characteristics. The best measure of this population so far devised is an estimate of the encysted egg population. While this may be adequate where it is desired to note changes in the level of the population following a particular crop or treatment, it is not nearly so satisfactory where a forecast of damage to an ensuing crop is required.

In examining cysts for viability, fungal hyphae and the fruiting bodies of other organisms were found inside. One of these, a fungus of the Order of Chytridiales, had fruiting bodies similar to microcysts (Triffitt, 1935. *J. Helminth.* 13, 59), and it is concluded that some part at least of the microcyst population of soils is composed of the fruiting bodies of fungi of this Order. Another organism, probably a fungus, caused blackening of the eggs. This was almost certainly a parasite, and its rather high incidence suggested that it might be of importance in reducing egg populations.

In conclusion, a number of suggestions are made for the adaptation of the technique for advisory purposes. Experience suggests that the general level of the egg population above which it is unsafe to grow sugar beet or mangolds on Fen soils is about 10 eggs per g. of air-dried soil or approximately 0.1 viable cysts per g.

812* PETHERBRIDGE, F. R., STAPLEY, J. H. & WOOD, J.

Wheat Bulb Fly Field Experiments.

Agriculture: J. Minist. Agric. 1945, 52, 351-4.

Experiments were carried out in the Holland Division of Lincolnshire, an area where wheat bulb fly is established as a pest, with a view to finding some cultural treatment to reduce losses. The experiments embraced (1) depth of ploughing, (2) time of sowing and (3) manuring.

Observations showed that mustard, sown as a catch crop following potatoes to keep the land covered during the egg-laying period of the fly, did not prevent egg-laying but that the wheat following was less attacked. Egg populations in badly attacked fields exceeded 1,000,000 per acre.

It was concluded that

- (1) Early drilling was a remedy for wheat bulb fly.
- (2) Different depths of ploughing and the application of superphosphate did not prevent attacks.

843* WRIGHT, D. W. & ASHBY, D. G.

Bionomics of the Carrot Fly (*Psila rosae* F.). 1. The Infestation and Sampling of Carrot Crops.

Ann. Appl. Biol. 1946, 33, 69-77.

The headlands of a carrot field are generally more heavily attacked by carrot fly larvae than the remainder of the field.

The methods of sampling a carrot crop are outlined: it has been found that, for fields up to 10 acres, samples of carrots taken in alternate twos and threes in the midfield, and in twos on the headlands, give a reliable measure of the infestation. For larger fields the number of carrots is doubled. Transects of headlands and whole fields have been made, and are useful in showing the actual amount of damage in a crop. Thus it is possible to represent each field as a three-dimensional body showing the amount and distribution of the attack.

The deterioration of attacked carrot crops during autumn and winter has been followed. Deterioration is measured by (1) percentage carrots attacked, (2) number of mines per 100 carrots, and (3) the percentage of carrots unsaleable or unfit for market. The relations between (1) mines per 100 carrots and time, (2) percentage attack and time, (3) mines per 100 carrots and percentage attack, and (4) mines per 100 carrots and percentage unsaleability are stated. Based on the above relationships, methods of prediction of deterioration have been worked out.

The importance of shelter in determining the degree and position of attack is discussed and the relative effects of different types of shelter on infestation are compared.

814* WRIGHT, D. W. & ASHEY, D. G.

The Control of the Carrot Fly (*Psila rosae* Fab.) (Diptera) with DDT.

Bull. Entom. Res. 1945, **36**, 253-68.

The proprietary emulsion "Guesapon", containing 5 per cent. DDT, gave an unsatisfactory control of carrot fly damage on a plot scale.

Treatment of the carrot foliage with this emulsion was more effective than treatment of the soil.

A 1 per cent. emulsion of DDT applied to carrot foliage in the field gave 100 per cent. mortality of carrot flies in the laboratory for 26 days after treatment and showed marked toxicity after a further 38 days.

The DDT spray deposits were very resistant to treatment with water and remained active after death of the foliage. They were also very toxic and lasting on potato foliage.

Deposits given by $\frac{1}{2}$ per cent. and 1 per cent. DDT emulsion were similar in toxicity and persistence. The $\frac{1}{2}$ per cent. is, however, slower in action.

From a treated surface the carrot fly is able to acquire a lethal dose of DDT in a very short time, probably by absorption through the feet.

Emulsions containing $\frac{1}{2}$ per cent. and 1 per cent. DDT applied to carrot foliage under cages in the field both gave 95 per cent. kill of carrot flies for a month after application. The treatments also gave a high kill of other insects.

Soil samples showed that the larval population and the damage was much lower in the treated than in untreated cages.

In a field trial $2\frac{1}{2}$ acres of carrots were treated with $\frac{1}{2}$ per cent. DDT emulsion at about 50 gals. an acre. Sweeping showed a rapid decline in abundance of flies after treatment and high mortalities were observed. These features did not occur on neighbouring untreated carrots.

These effects lasted for some 21 days after treatment and a marked reduction of larval population and damage resulted.

OTHER PAPERS

MORLEY, D. W. **Ant Gynandromorphs and other Mosaics.** *Nature, Lond.* 1946, **157**, 741.

822* PETHERBRIDGE, F. R. & WESTON, W. A. R. D. **Frit Fly.** *Agriculture : J. Minist. Agric.* 1946, **52**, 463-5.

AGRICULTURE

836* HUDSON, H. G.

Weed Control in Norfolk. A New Method.

Agriculture : J. Minist. Agric. 1946, **53**, 22-7.

This article describes trials carried out on 186 fields with the weed control material 2-methyl 4 chlorophenoxyacetic acid, more commonly known as MCPA, or, when mixed with chalk, Agroxone.

Applications of 2 lbs. per acre mixed with chalk and applied at 2 cwts. per acre, and of 1 lb. per acre as a spray with 70-100 gals. of water were made; effects on both crops and weeds were noted. At these rates yellow charlock and pennycress were completely controlled, wild radish was controlled if conditions were favourable, and various other weeds were checked. Thistles and docks were killed in many cases, especially when the material was applied in late May. The efficiency of the control was unaffected either by the size of weed at the time of application or the density of the application, but was reduced if heavy rain fell within 48 hours of application.

No damage to any crop (except cocksfoot for seed) was seen, and it was concluded that MCPA was 'a most promising weed control material'.

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EDE, R. **The Principles of Agriculture.** Pp. xiv + 272, with 23 figs. Pitman, 1946. Price 15s.

HUNTER, H. **Winter Wheats.** Contribution to *Farming Handbook* No. 3. Pp. 1-8. Jarrold, 1945. Price 5s.

MANFIELD, W. S. **Self Sufficiency as Opposed to the Purchase of Stores in the Economic Production of Beef.** Contribution to *The Future of British Farming. Conf. No. 2. Essex W.A.E.C.*, 1945-6. Pp. 63-70. Price 1s.

ANIMAL BREEDING AND GENETICS

844* CHANG, M. C.

Fertilizing Capacity of Spermatozoa Following Cold Treatment of the Scrotal Testes of Rabbits.

J. Exp. Biol. 1946, **22**, 95-100.

Doe rabbits were inseminated with sperm suspensions containing a known number of morphologically normal sperms, together with a known number of tailless sperm heads, produced artificially by cold treatment of the scrotal testes. The fertilizing capacity of the mixture, as determined by the percentage of fertile inseminations and the average number of young born, remained normal so long as a minimal number of normal sperms (viz. 3 millions) was maintained, irrespective of whether a high percentage of sperm heads (viz. 17-95)

was present or not. The isolated sperm heads had obviously no fertilizing capacity. Partial fertility occurred when the number of morphologically normal sperms was less than 3 millions and sterility when the number was less than 1 million.

When a similar series of inseminations were done with spermatozoa from normal untreated males, the minimal number of normal sperms required for full fertility was 0.33 million, or rather less. This indicates that apparently normal sperms which are present in ejaculates after low temperature treatment of the testis are only morphologically normal and not physiologically normal. It is concluded from these results that the diagnosis of fertility or sterility, based only upon sperm morphology, may be inaccurate and misleading. A seminal specimen containing a high proportion of abnormal forms may be quite fertile provided it contains a sufficient absolute number of viable sperms, and conversely, spermatozoa which may appear morphologically normal may not be physiologically capable of effecting fertility.

The sex ratio of the offspring was not significantly disturbed when does were inseminated with sperms produced after cold treatment of the testes. The efficiency of artificial insemination as a method of ensuring high fertility has been demonstrated.

826* CHANG, M. C.

Sperm Production of Adult Rams in Relation to Frequency of Sperm Collection.

J. Agric. Sci. 1945, **35**, 243-6.

Semen was collected in two successive matings three times a day for 10 days, then two successive matings every day for 10 days and finally two successive matings once every alternate day for 10 days. It is concluded that the content of the epididymis does not alter very considerably with different rates of ejaculation but that the number of spermatozoa is kept relatively constant either by decreased spermatogenesis or increased absorption during periods of sexual repose and infrequent collection, or alternatively by increased stimulation of spermatogenesis due to ejaculation during periods of sexual activity.

857* HAMMOND, J.

Problems of Pig Breeding.

Brit. Soc. Anim. Prod. Rep. 3rd and 4th Meet., 17 Jul., 1945, 72-83.

The problems of pig breeding are treated under two headings, those affecting (1) the commercial producer and (2) the pedigree breeder. The trends in breeding policy from 1914 are outlined and suggestions made for the organization of breeding under present conditions.

PEASE, M. S.

Observations on Heritable Disease in Poultry.

Ann. Appl. Biol. 1945, **32**, 279.

Fowl paralysis was first noticed in the Cambridge flock in 1930, the incidence rising to an alarming peak in 1935 and thereafter declining to negligible proportions in 1939. An analysis of this incidence year by year disclosed no evidence of inheritance.

It was shown that in the case of non-specific mortality, the determining factor was whether the mother lived or died during the breeding season. The evidence seemed to show that the quality of the egg cytoplasm was in some way affected.

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HAMMOND, J. **Artificial Insemination.** Contribution to *Guernseys. The Golden Butter Breed.* Pp. 31-33, (1946).

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PEASE, M. S. **Cambridge Autosexing Breeds.** *Autosexing Annu.* 1946, 5-13.

WALTON, A. **Breeding Methods in Livestock Improvement.** *Nature, Lond.* 1946, **157**, 523.

WALTON, A. **Notes on the Technique of Artificial Insemination.** Holborn Surgical Instrument Co., 1945. Price 1s. Pp. 32.
(A French edition of this booklet has also been issued).

ANIMAL NUTRITION

827* HALNAN, E. T.

Value of Wheat Offals for Pigs and Poultry.

Proc. Nutrit. Soc. 1946, **4**, 37-51.

Wheat bran, in small amount, is useful as an ingredient of pig and poultry rations, but its use in large amount is contra-indicated, particularly in fattening rations.

Wheat offals are useful ingredients of pig and poultry rations, particularly as a source of the members of the vitamin B complex, vitamin B₁, riboflavin, nicotinic acid, and pyridoxine.

As a source of energy for pigs and poultry, the finer wheat offals such as middlings or weatings, are preferable to the coarser ones such as pollards and bran.

The manganese content of wheat offals renders these products of value as a source of this trace element in pig and poultry rations.

852* PETTIT, G. H. N.

Wartime Changes in the Winter Diet of Dairy Cows in the Eastern Counties of England.

J. Agric. Sci. 1946, **36**, 222-5.

The general characteristics of a group of thirty-nine herds of dairy cows in the Eastern Counties of England, and the method of obtaining information about their diet during the winters 1938-9 to 1942-3 inclusive, are briefly discussed.

The first three winters of the war show a continuous decline in starch equivalent and protein equivalent per cow, followed by a recovery during winter 1942-3.

Comparing winter 1942-3 with winter 1938-9, consumption per cow of concentrates declined by one-third, reductions in proprietary compounds and mixtures and in maize and wheat products being outstanding.

The more important increases were in oats, straw and succulent foods, notably mangolds, sugar-beet tops and kale.

Hay retained its important place with little over-all change; a modest increase in silage was restricted to a few herds.

The crude weight of the average daily ration increased from 44 to 61 lb., but its dry matter only from 21.0 to 22.6 lb.

The residue: total dry matter less digestible organic matter—increased from 7.2 to 8.4 lb. per cow daily. Reference is made to changes in palatability.

862* POMEROY, R. W.

The Effect of a Submaintenance Diet on the Composition of the Pig.

J. Agric. Sci. 1941, **31**, 50-73.

Five inbred Large Whites from the same strain as used by McMeekan (1940) were reared on a High Plane of nutrition to approximately 330 lb. live weight at which one was killed as a control. The rest were put on to a submaintenance diet of straw and water and killed successively at roughly equal intervals in live weight between 330 and 200 lb. The weights of blood, organs and offals were determined and the carcasses were jointed and completely dissected into their constituent tissues. The total weights of each and the weights within the various joints were recorded.

Organs. The early-maturing organs, brain, eyes, etc., continued to grow. Other organs like the heart, liver, lungs, etc., suffered a greater or less degree of atrophy which was probably determined by a suspension of their functions.

Carcass composition. The tissues of the carcass were affected in reverse order to their development, i.e. fat most, muscle less and bone least. Bone continued to grow in the earliest stages of submaintenance.

The joints were also affected in inverse ratio to their order of development. Within the fat depots the later developing kidney fat reduced first, then the subcutaneous fat and lastly the early-developing inter-muscular, caul and mesenteric fat.

Within the subcutaneous fat the later-maturing inner layer is affected more than the early-maturing outer layer.

838* WOODMAN, H. E. & EVANS, R. E.

The Horse-chestnut as a Source of Food for Livestock. I. The Composition, Digestibility and Nutritive Value of Alcohol-extracted Horse-chestnut Meal and Horse-chestnut Residue.

J. Agric. Sci. 1946, **36**, 29-41.

Repeated attempts have been made, both during the recent war and the war of 1914-18, to make the store of starch and other nutrients in the horse-chestnut available for farm animals. Unfortunately, the extremely bitter taste of the horse-chestnut, due to the presence of saponins and, to a smaller extent, of tannins, has proved a severe obstacle, and horse-chestnuts have been found to be an unsuitable food for livestock both on account of their unpalatable character and their constipating action. Methods of de-bittering the nuts, capable of being carried out on the farm, have yielded disappointing results, and it is now felt that should the need for utilizing horse-chestnuts in the feeding of livestock ever arise, the extraction of saponin and tannin can only be achieved satisfactorily on a large scale by means of a factory process, in which the completeness of the removal of the bitter substances can be controlled by chemical tests, and the resultant extracted residue, which readily turns mouldy, be dried artificially for safe storage. The saponin thus removed from the horse-chestnuts would be of value to the cosmetics industry on account of its foam-producing properties.

During recent years Messrs. Macleans Ltd. have been investigating the possibility of utilizing horse-chestnuts as a source of glucose and saponin. As a consequence three de-bittered horse-chestnut products became available for feeding trials with sheep and pigs: (1) a meal resulting from the exhaustive extraction of horse-chestnuts with 70% methyl alcohol at 55°C., (2) a meal prepared by exhaustive extraction of horse-chestnuts with water at 55°C., and (3) a residue remaining after extraction of horse-chestnuts with 70% methyl alcohol at 55°C. and subsequent removal of the starch by diastatic hydrolysis. A description of the industrial processes whereby these products are obtained is included in the text.

The present communication deals with the composition, digestibility and nutritive value for pigs and ruminants of these three horse-chestnut products. Both the alcohol-extracted and water-extracted meals are essentially carbohydrate-rich foods, containing but small percentages of protein and minerals. The removal of starch from the extracted meals gives rise to a residue of distinctly poorer composition, the percentage of N-free extractives falling from about 74 to about 53% (dry-matter basis), with a corresponding rise in the percentage of crude fibre. All three products, on the basis of dry matter, contain round about 7% of ether extract.

The rations of the sheep in the different periods of the digestion trials contained 45% of the alcohol-extracted meal, 37% of the water-extracted meal and 37% of the horse-chestnut residue, the corresponding amounts in the pig digestion rations being 37.7, 29.8 and 37.7% respectively. No difficulty was experienced at these levels of feeding in securing consumption of the experimental rations. No digestive disturbances were noted in the sheep or pigs in any period of the trial, though in all cases the faeces were distinctly drier in texture than in the periods when the animals were subsisting on the basal diets.

The horse-chestnut residue, resulting from the removal of starch from the alcohol-extracted meal by diastatic hydrolysis, was found to have a poor feeding value. Sheep were able to digest only 33.8% of the organic matter in the product and, although the ether extract and N-free extractives were assimilated to a satisfactory degree, this was offset by the striking negative digestion coefficients obtained in the cases of crude protein and crude fibre. The starch equivalent, on the basis of dry matter, amounted to no more than 34.1. These findings were confirmed by the results of the pig digestion trials. Negative digestion coefficients were again obtained for crude protein and crude fibre and, although the ether extract and N-free extractives were moderately well assimilated, the digestion coefficient of the total organic matter was only 33.5%. Clearly the residue obtained as a by-product of the manufacture of glucose and saponin from horse-chestnuts has very little significance as a food for livestock.

The satisfactory digestion coefficients of 71.9 and 69.8% obtained respectively in the sheep digestion trials for the N-free extractives in the alcohol-extracted and water-extracted meals suggest that these products should prove valuable sources of digestible carbohydrate for sheep and cattle. Values of the same order (73.2 and 72.9%) were derived from the pig digestion trials. Negative digestion coefficients were obtained from the sheep tests for the crude protein and crude fibre in the extracted meals, whilst in the pig trials the corresponding digestion coefficients were positive, though of a low magnitude.

On the basis of dry matter, the extracted meals contain as much digestible N-free extractives as oats and have a starch equivalent approximately equal to nine-tenths of the value for the cereal grain. These findings were confirmed by the results of the pig digestion trials, the extracted meals containing, on the basis of dry matter, approximately nine-tenths as much 'total digestible nutrients' as is contained in ground oats. It must be kept in mind, however, that the extracted meals supply little or no digestible protein and are inferior to oats in respect of palatability.

The value of the extracted horse-chestnut meals lies solely in their content of digestible carbohydrate (consisting substantially of starch) and of digestible oil. During times of food scarcity they should prove useful as a partial substitute for cereals in the rations of livestock provided (1) the ration is made up so as to be suitably balanced in respect of protein and minerals, and (2) the allowance of extracted horse-chestnut meal is restricted to a level that does not adversely affect the palatability of the ration and so reduce food consumption. In this regard the incorporation of a little molasses with the meal would help to safeguard palatability.

The value of both extracted meals would have been enhanced if the shell had been removed before proceeding with the extraction. Although decortication of the fresh nut is not easy to accomplish, this should not be difficult after the nuts have been dried by artificial heat to render them safe for storage, since during this process the kernel shrinks away from the shell, which itself becomes very brittle and easy to crack.

839* WOODMAN, H. E. & EVANS, R. E.

The Horse-chestnut as a Source of Food for Livestock. II. The Value of Alcohol-extracted Horse-chestnut Meal, Water-extracted Horse-chestnut Meal and Horse-chestnut Residue as a Partial Substitute for Cereals in the Rations of Bacon Pigs.

J. Agric. Sci. 1946, **36**, 42-55.

Two large-scale feeding trials have been carried out with the object of testing the validity of findings from pig digestion trials in respect of the nutritive value of horse-chestnut residue (a by-product of the manufacture of saponin and glucose from horse-chestnuts), and of alcohol-extracted and water-extracted horse-chestnut meals.

Trial I. The horse-chestnut residue was fed in two separate periods, the first from 50 to 100 lb. live weight, when the residue constituted 20% of the total ration, and the second from 190 lb. to slaughter weight, when the allowance was increased to 30%. In both periods the residue replaced an equal percentage of ground oats in the control ration.

Despite the unpromising appearance of the horse-chestnut residue, which was almost coal black in colour, the pigs did not find it unappetizing, and they quickly became accustomed to the new flavour and ate their full rations quite readily. They remained perfectly healthy on the diet containing the residue, and although the dung was black in colour and rather dry in texture, no signs of constipation or other digestive troubles were observed.

The twenty pigs receiving horse-chestnut residue required, on an average, 7 days longer than the control pigs to increase in live weight from 50 to 100 lb. Over this range they showed an average consumption of 194.25 lb. of food per head, consisting of 155.4 lb. of meal and 38.85 lb. of horse-chestnut residue, compared with 169.41 lb. of pig meal per head among the control animals. The feeding of about 2½ lb. of the residue effected a saving of 1 lb. of pig meal. This figure, however, somewhat under-estimates the productive value of the residue, since it does not take into account the fact that the diet had to provide the maintenance requirements of the animals for 7 days longer than was the case with the control animals.

The horse-chestnut residue gave even poorer results when the allowance was increased to 30% at 190 lb. live weight. During this final period the animals averaged only 0.96 lb. of live-weight increase per day, with a mean food conversion factor of 7.39 lb. per lb. of live-weight gain, compared with the corresponding values of 1.25 and 5.66 lb. for the control pigs. It is concluded that the horse-chestnut residue has a low feeding value for bacon pigs, a finding that is in agreement with the inference from the results of the pig digestion trials.

As the pigs receiving horse-chestnut residue reached 100 lb. live weight, the residue was gradually replaced by alcohol-extracted horse-chestnut meal, the pigs on treatment A receiving 20% and those on treatment C 30%. In both cases the horse-chestnut product replaced an equal percentage of ground oats in the control treatment B. The comparison was carried out over a range of live weight from 110 to 190 lb.

No ill-effects were noted from the inclusion of the alcohol-extracted meal in the ration, but it was concluded that an allowance equal to 30% of the total ration exerts an adverse effect on the palatability of the ration as a whole and is to be regarded as excessive.

The pigs receiving 20% of the alcohol-extracted meal in replacement of 20% of ground oats increased in live weight at the average rate of 1.19 lb. per day, compared with 1.29 lb. per day in the case of the control pigs. The corresponding mean efficiencies of food conversion were 4.93 and 4.55 of meal per lb. of live-weight increase. Analysis of the data for food consumption showed that a saving of 1 lb. of pig meal was made possible by the feeding of 1.64 lb. of alcohol-extracted horse-chestnut meal, but when adjustment was made for the fact that the diet containing the horse-chestnut product had to provide the maintenance requirements of the pigs for 5.3 days longer than was the case with the control animals, it was revealed that 1 lb. of ground oats is equal to 1.11 lb. of the alcohol-extracted meal as a carbohydrate food for bacon pigs. This finding is in very close agreement with the conclusion from the pig digestion trials.

The raising of the level of replacement of ground oats by alcohol-extracted horse-chestnut meal from 20% in treatment A to 30% in treatment C caused the mean rate of live-weight increase to be depressed from 1.19 to 1.10 lb. per day, with a corresponding increase in the food conversion factor from 4.93 to 5.26 lb. These poorer results are to be ascribed to the detrimental influence of the higher percentage of alcohol-extracted meal on the palatability of the ration, in consequence of which it became necessary at times to reduce somewhat the daily meal supply to certain of the pigs on treatment C in order to ensure complete food consumption. This in turn reacted adversely on the results for live-weight increase and efficiency of food conversion. It was found, however, that those pigs on treatment C which remained on full rations throughout the period of comparison gave results that were very little inferior to those for the A pigs receiving 20% of the horse-chestnut product in their rations.

Trial II. The control treatment B in this test was identical with that fed in the first trial. The pigs on treatment A received rations containing 20% of water-extracted horse-chestnut meal over the whole trial from 50 to 200 lb. live weight. From 50 to 100 lb. live weight the rations fed to the animals on treatment C contained 20% of alcohol-extracted horse-chestnut meal and included an amount of molasses equal to 10% of the weight of horse-chestnut product. At 100 lb. live weight, the alcohol-extracted meal was replaced gradually by the water-extracted meal, molasses being added as before, whilst at 150 lb. the water-extracted meal was increased to 30%, the supplement of molasses still being kept at the level of 10% of the weight of horse-chestnut product. As in Trial I, the horse-chestnut products replaced an equal weight of ground oats in the control diet.

From 50 to 100 lb. live weight, the progress of the C pigs, receiving 20% of the alcohol-extracted horse-chestnut meal (with molasses), was almost equal to that of the control pigs, and the results were consistent with the finding from the digestion trials, namely, that 1 lb. of ground oats, on the air-dry basis, contains as much 'total digestible nutrients' as 1.09 lb. of the horse-chestnut product. The A pigs, receiving 20% of the water-extracted meal and no molasses, made somewhat poorer gains, averaging 0.95 lb. per day compared with 1.05 lb. for the C pigs.

Over the range of 100–150 lb. live weight, the pigs on treatment C, which now supplied 20% of the water-extracted meal with molasses, again gave results that were not seriously inferior to those for the control animals, a finding that is in harmony with the conclusions from the digestion trials, namely, that the water-extracted and alcohol-extracted meals contain approximately equal percentages of 'total digestible nutrients' and that both products are little inferior in this regard to ground oats. The A pigs over this period gave somewhat poorer gains than the animals on treatment C, averaging 1.16 lb. live-weight increase per day as against 1.23 lb. Both groups of pigs were consuming full rations, which differed merely in respect of the small allowance of molasses supplied to the C pigs.

In the final period of feeding (150–200 lb. live weight), the C pigs were markedly less thrifty than the control animals. The double change, consisting of the replacement of white-fish meal by extracted, decorticated ground-nut meal and the increase in the allowance of water-extracted horse-chestnut meal from 20 to 30%, had the effect of rendering the ration rather unpalatable, despite the added molasses. As a consequence, it became necessary to reduce the daily food supply of the C pigs from time to time, and this naturally reacted detrimentally on the rate of live-weight gain and efficiency of food conversion. Clearly 30% of water-extracted horse-chestnut meal, even when supplemented by 10% of its weight of molasses, must be regarded as an excessive allowance, because of its unfavourable effect on palatability and consequently on food consumption. Alternatively, however, better results might have been obtained if the allowance of molasses had been increased from 10% of the horse-chestnut product to 10% of the total ration.

Over the trial as a whole (50–200 lb. live weight), the A and C pigs averaged respectively 1.06 and 1.11 lb. of live-weight increase per day, compared with 1.20 lb. in the case of the control animals. Even in the case of the control pigs, therefore, the mean rate of live-weight gain was rather low in comparison with peace-time standards. This is to be attributed to the war-time nature of the diet, however, which consisted substantially of ground oats and fine millers' offals. The substitution of these by barley meal and pre-war fine wheatfeed would undoubtedly have increased the thriftiness not only of the control animals, but also of the pigs subsisting on the rations containing the horse-chestnut meals.

OTHER PAPERS

HALNAN, E. T. *Palatability in Poultry Foods*. *Thorley's Fmr's Alm. & Diary*. 1946, pp. 42-5.

ANIMAL PHYSIOLOGY

MARSHALL, F. H. A. & HALNAN, E. T.

Physiology of Farm Animals. 4th ed.

Pp. xii + 339, with 119 illus. Camb. Univ. Press, 1946. Price 18s.

ANIMAL PRODUCTION

858* HAMMOND, J.

Beef Production.

Agriculture : J. Minist. Agric. 1946, **53**, 34-8.

Suggestions for the remodelling of beef production in this country are set out under the following headings :— economic factors, history of beef production, future methods of breeding, rearing, and eliminating the store period.

823* WALLACE, L. R.

The Composition of Sheep Foetuses.

J. Physiol. 1945, **104**, 33P.

The weights of some of the major parts of Suffolk × Border-Leicester-Cheviot sheep foetuses from 56 to 112 days are tabulated. It is apparent that organs such as the kidney, liver, lungs, bladder and brain make a larger proportion of their foetal growth during the early stages than do parts such as the spleen, thymus, intestines and skeleton. The differential nature of growth is clearly evident.

WALLACE, L. R.

The Effect of Diet on Foetal Development.

J. Physiol. 1945, **104**, 34P.

A preliminary account of experiments on the effects of feeding ewes on a much restricted ration during the last 8 weeks of pregnancy. Lamb weights were only 57% of those from liberally fed ewes. Foetuses which are small as a result of malnutrition of the mother are not mere miniatures of large ones of the same age but some organs are affected more than others.

OTHER PAPERS

821* HAMMOND, J. **The Bull.** *Nat. Milk Rec., Camb. Br. Annu. Rep.*, 1945.

863* TOSIC, J. & WALTON, A. **Respiration of Spermatozoa in Egg-yolk Medium.** *Nature, Lond.* 1945, **156**, 507-8.

PLANT BREEDING AND GENETICS

ASHTON, T.

The Use of Heterosis in the Production of Agricultural and Horticultural Crops.

Imp. Bur. Plant Breed. Genet., Cambridge, 1946. Pp. 30. Price 3s.

Information on the commercial use of hybrid vigour in the chief self-pollinated, cross-pollinated and asexually propagated crops and in forest trees is summarized.

The bulletin includes a bibliography of 234 references.

BELL, G. D. H.

Crops and Plant Breeding.

J. R. Agric. Soc. 1945, **106**, 1-12.

This annual survey is confined essentially to the practical problems of food production in England. It deals with the use of management of natural grazings : the use of the temporary ley in maintaining soil fertility : strains of herbage plants : fertilizer placement : recent research in potatoes, mangolds and cereals : and new weed killing chemicals.

853* BELL, G. D. H.

Induced Bolting and Anthesis in Sugar Beet and the Effect of Selection of Physiological Types.

J. Agric. Sci. 1946, **36**, 167-83.

The behaviour of progenies of single plants and bulks showing anthesis at different dates was studied, and differences in the time and period of anthesis of the progenies were found. Selection of non-bolting plants from light-treated material resulted in progenies showing extreme resistance to bolting, but differences were found in this respect between non-bolting progenies of the strains Dobrovica and Hilleshög. Considerable effects of low temperature and continuous light treatment of seedlings and young plants were found, there being very obvious differences in habit and foliage characters between controls and treated. Rapid bolting was obtained by growing in continuous light in the glasshouse during the winter and early spring. The paper concludes with a discussion on the significance of physiological development to commercial sugar beet growing.

867* CÁRDENAS, M. & HAWKES, J. G.

New and Little Known Wild Potato Species from Bolivia and Peru.

J. Linn. Soc. 1946, **53**, 91-108.

One new series within the genus *Solanum*, seven new species and a number of varieties and forms are described. The taxonomy of certain other *Solanum* species is also dealt with.

818* CHIN, T. C.

The Cytology of Some Wild Species of Hordeum.

Ann. Bot. 1941, **5**, 535-45.

Some taxonomic description is given of the wild species of *Hordeum*, the cytology of which is examined. *H. pusillum* Nutt. and one of the two forms of *H. nodosum* L. each has 14 mitotic chromosomes and 7 bivalents in meiosis, one pair having satellites.

H. gussoneanum Parl., a second form of *H. nodosum* L., *H. jubatum* L., and two forms of *H. murinum* L. (from England and U.S.A. respectively) have 28 somatic chromosomes and 14 bivalents at meiosis, no multivalents being observed; each has two pairs of chromosomes with satellites. The diploid and tetraploid forms of *nodosum* came from different altitudes in California.

The numbers found do not always agree with those found by other authors, nor do these authors agree among themselves. This is probably due to polyploidy within the species, but may sometimes be due to differences in nomenclature since the taxonomy is very confused.

No relation was found between number of chromosomes and size of cells.

H. bulbosum L. with 28 somatic chromosomes behaves at meiosis like an autotetraploid, with a very small degree of hybridity as evidenced by the occurrence of bridges in both the first and second meiotic divisions. Misdivision of the centromere was observed in univalent chromosomes in both divisions. The chromosome configurations of the first meiotic metaphase have been compared with those obtained by other authors in autotetraploids.

851* FYFE, J. L.

Polyploidy in Sainfoin.

Nature, Lond. 1946, **158**, 418.

Evidence is presented that sainfoin (*Onobrychis viciaefolia* Scop) is either an autotetraploid or an allotetraploid derived by chromosome doubling of a hybrid with a high degree of chromosome pairing.

837* HAWKES, J. G. AND

845* DRIVER, C. M.

Origin of the First European Potatoes and their Reaction to Length of Day.

Nature, Lond. 1946, **157**, 591: **158**, 168.

Both letters are in reply to criticisms levelled by Dr. J. E. van der Plank on hypotheses held by the authors on the origin of the first European potatoes.

828* HOWARD, H. W. & MANTON, I.

Autopolyploid and Allopolyploid Watercress with the Description of a New Species.

Ann. Bot. 1946, **10**, 1-13.

By means of an autotetraploid produced from diploid watercress (*Nasturtium officinale* R.Br.) by colchicine treatment, the wild tetraploid watercress previously described by Manton (1935) has been shown to be an allotetraploid.

By analysis of chromosome pairing at meiosis in diploid, autotetraploid, wild tetraploid, and two hybrid forms of watercress, it has been shown that half the chromosomes of the wild tetraploid are homologous with the chromosomes of diploid *N. officinale* R.Br. The identity of the other half of the genome of the wild tetraploid is uncertain, but is suspected to be a species of Cardamine.

The name *Nasturtium uniseriatum* is proposed for the wild tetraploid. Diagnoses of this new species and the other two wild forms of watercress are given.

The breeding behaviour of the wild triploid (*N. uniseriatum* × *officinale*) is described. Its possible evolutionary significance is discussed.

HUDSON, P. S.

Plant Breeding and Genetics To-day.

Advance. Sci. 1945, **3**, 252-67.

The role in plant breeding of selection, intraspecific and interspecific hybridization, and natural and artificially induced polyploidy, is described. The importance is shown of the impact upon genetics of recent findings in the chemical approach to biological problems, such as the nature of the virus, and a discussion is given of the significance of work by Russian scientists, notably Lysenko and Mičurin, who base their investigations upon principles of non-Mendelian inheritance.

HUDSON, P. S. & RICHENS, R. H.

The New Genetics in the Soviet Union.

Imp. Bur. Plant Breed. Genet., Cambridge. Pp. 88. Price 6s.

A detailed account is given of the genetical school that has arisen in the Soviet Union in recent years, and which is associated with the name of Academician Lysenko. This school was founded by Lysenko and Prezent about the year 1935, and became dominant in Russia in 1940. It still flourishes, though perhaps less now than formerly.

Its characteristic tenets are derived from the writings of Darwin, Timirjazev, Mičurin and Burbank, whose theories have been synthesized with the philosophy of dialectical materialism. In contrast to western procedure, much of the scientific discourse of Lysenko's school is alogical, i.e. derives its conclusions not by logical argument from the facts, but by appeal to chosen authorities, by condemning views in opposition to these authorities, by analysing the presumed states of mind of its opponents, and by estimating the value of theories by their agronomic usefulness.

The facts reported by Lysenko in support of his system are as follows:—

- (1) An F_1 hybrid cannot be later than its earlier parent.
- (2) Biologically advantageous characters are dominant.
- (3) F_2 transgressive segregation for earliness is impossible.
- (4) Pure lines necessarily degenerate on selfing.
- (5) Intravarietal crossing gives rise to increased vegetative vigour.
- (6) Genetic variation is induced by environmental factors.
- (7) Segregation ratios are determined by the environment.
- (8) F_2 hybrid progenies may fail to segregate.
- (9) The F_1 generation of homozygous parents may be heterogamous.
- (10) Reciprocal hybrids may differ *inter se*.
- (11) Different parts of the same individual may differ genetically.
- (12) F_1 hybrids may exhibit a mosaic of tissues derived from either parent respectively.
- (13) Grafting may bring about genetic interaction between stock and scion.

Many of these generalizations are stated by Lysenko and Prezent to hold only under appropriate but unspecified environmental conditions. Much of the evidence for them is inconclusive.

The hypothesis advanced by Lysenko to cover these presumed facts is the nutrient theory. Organisms are regarded, not as enduring entities, but as streams of stages, each stage arising from the preceding through absorption (assimilation) by the preceding stage of environmental elements (nutrients) to give a new compound, the next stage in development. Each generation is regarded as a cycle of developmental stages. The similarity between parents and offspring is attributed to conservatism, a property of all living matter. Assimilation of nutrients is not at random but selective, organisms having the power to select nutrients which will combine with the organism to produce a biologically advantageous course of development. Selective fertilization, the selection by the ovum of biologically advantageous pollen grains, here acting as nutrients, is a special manifestation of the organism's general capacity for selective assimilation. If the nutrients are not of like nature to the selecting organism its conservatism is overcome and new cycles of development are initiated. In this way the environment can modify the nature of organisms. Local differences between nutrients within an individual plant result in internal genetic variation. When this occurs in the sporogenous tissue, differentiation of gametes and subsequent segregation occur. Hybridization is regarded as an additive process, leading to the combination in one plant of two developmental potentialities, while segregation is conceived as a subtractive process dispersing developmental potentialities. Crossing is supposed to result in hybrid vigour through the combination of dialectically opposite gametes; selfing is believed to be deleterious through the absence of dialectically opposite gametes. Biologically advantageous characters are believed to be dominant, the organism selecting those nutrients which will combine with it to initiate the most favourable cycle of development.

These theories, although exhibiting a certain degree of internal coherence, contain various inconsistencies and receive only slight support from the facts. Lysenko's rejection of the data accumulated by Mendelian genetics during the past thirty years is obscurantist and reduces the value of his speculations.

Mendelian genetics is criticized by Lysenko for its failure to conform to his chosen authorities, for its claimed inconsistency with dialectical materialism, and for the supposed discrepancies between its tenets and Lysenko's experimental results. These criticisms are not adequately substantiated by Lysenko and his followers.

RICHENS, R. H.

Forest Tree Breeding and Genetics.

Imp. Bur. Plant Breed. Genet., Cambridge, 1945. Pp. 79. Price 5s.

In this bulletin, the more important papers on forest tree breeding that have appeared since 1930 are summarized and reviewed. General principles of tree breeding are described in an introductory section with a brief account of the basic theoretical concepts involved. The methods so far used include line breeding, a slow, but valuable technique; the development of hybrids exhibiting heterosis; and the utilization of polyploids.

The selection criteria that have been used by tree breeders include timber yield, photoperiodic adaptation, high reproductive capacity, tree shape, wood quality, competitive ability, and resistance to bacteria, fungi, insects, viruses, low temperature and other unfavourable environmental conditions. These characters are

considered in general and with special reference to the tree genera treated in the bulletin, viz. *Abies*, *Cupressus*, *Juniperus*, *Larix*, *Picea*, *Pinus*, *Pseudotsuga*, *Sequoia*, *Tsuga*, *Acer*, *Aesculus*, *Alnus*, *Betulus*, *Buxus*, *Carpinus*, *Carya*, *Castanea*, *Eucalyptus*, *Fagus*, *Fraxinus*, *Ilex*, *Juglans*, *Platanus*, *Populus*, *Pterocarya*, *Quercus*, *Robinia*, *Salix*, *Tectona*, *Tilia* and *Ulmus*.

A glossary of technical terms is appended.

OTHER PAPERS

HUDSON, P. S. **How New Crops are Found.** *Countryman*. 1946, **34**, 43.

HUDSON, P. S. **Work on the South American Potato Collection up to 31st December, 1944.** 15th Annu. Rep. Exec. Council. Imp. Agric., Bur. 1943-1944 (1945), 22-3.

PLANT NUTRITION

846* JOHNSON, D. A. & WOODMAN, R. M.

Plant Growth with Nutrient Solutions. I. A Brief Review of Existing Work.

J. Agric. Sci. 1946, **36**, 69-79.

A brief but comprehensive summary of research carried out on plant growth with nutrient solutions followed by an extensive bibliography.

840* WOODMAN, R. M. & JOHNSON, D. A.

The Nutrition of the Carrot. III. Grown in a Gravel Soil.

J. Agric. Sci. 1946, **36**, 10-17.

The nutrition of the carrot in a light gravel soil of known analysis with high available phosphate has been studied by statistical pot-culture methods, and the responses, linear and curvature components, etc., due to nitrogen, phosphate, and potash, have been calculated.

No hard and fast rule can be made as to the adequacy or otherwise of any particular fertilizer in a soil, as the different parts of the plant (top and root) were shown to be capable of responding quite differently to that fertilizer.

There was a positive response in yield of fresh roots to dressings of potash, and, simultaneously, a negative one in yield of tops, so that the top/root ratio for fresh matter was largely with a deficiency of potash; this finding has been borne out by field trials and by sand cultures of carrots. There was absolutely no response to potash as regards the dry-matter content of the tops, roots, and whole plants; but dressings of potash decreased the moisture content of the tops and increased that of the roots, and the large top/root ratios for fresh matter encountered in the absence of potash were found to be entirely due to moisture content, the ratios being uninfluenced when calculated for dry matter.

Applications of nitrogen resulted in increases in the dry matter in the tops and whole plants, but not the roots, and the increase in yield obtained for the fresh roots of the carrots with nitrogen was due to increased water content. The moisture in the tops was decreased in amount by nitrogen applications.

Phosphate caused absolutely no response in fresh yields of tops, roots, or whole plants. It did, however, increase dry matter in the tops, though not in the roots, and decreased the moisture content of the tops and increased that of the roots; the net consequence of these effects was that the top/root ratio for fresh matter was uninfluenced, but that there was an increase in this ratio for dry matter.

847* WOODMAN, R. M. & JOHNSON, D. A.

Plant Growth with Nutrient Solutions. II. A Comparison of Pure Sand and Fresh Soil as the Aggregate for Plant Growth.

J. Agric. Sci. 1946, **36**, 80-86.

Statistical experiments have been carried out as pot cultures in the greenhouse, with sand and soil as the aggregates (nutrients being supplied to both aggregates in the form of nutrient solutions), on the growth of the two vegetables turnip and spring cabbage to the stage of maturity usual in actual practice. With full nutrients, the soil, possibly because of such factors as its nutrient reserves, its physical properties, and its capacity for retaining certain nutritional elements supplied, was superior to the sand as judged by yields of fresh and dry matter for tops and whole plants of both vegetables, and roots for the turnip, thus including the edible portion of both plants; the (true) root of the cabbage, however, yielded more in the sand under these conditions. Similar results were obtained even when the concentrations of the nutrients for the soil were only half those in the full nutrient solution applied to the sand, so that it may be stated that fresh soil is greatly superior to sand under equal conditions as an aggregate in the growth of vegetables with nutrient solutions.

848* WOODMAN, R. M. & JOHNSON, D. A.

Plant Growth with Nutrient Solutions. III. A Comparison of Sand and Soil as the Aggregate for Plant Growth, using an Optimum Nutrient Solution with the Sand, and Incomplete Supplies of Nutrients with 'Once-Used' Soil.

J. Agric. Sci. 1946, **36**, 87-94.

Experiments are described in which the 'once-used' soils left over from previous culture experiments were employed as aggregates in the growth of vegetables. It was demonstrated that sand with full nutrients was superior to 'once-used' soil with water only, but that 'once-used' soil supplied with the full quota of soluble nitrogen was superior to the sand with full nutrients. The root of the cabbage in sand was an exception,

and a possible explanation was that sand as aggregate favoured true root formation, while soil favoured the formation of tops. The 'once-used' soil in these experiments deteriorated in physical properties owing to the conditions of the experiment, which included the use of nitrogen as sodium nitrate, possibly owing to the tendency to the formation of sodium clay; it is argued that a judicious choice of fertilizers and/or the use of flocculating electrolytes should overcome such tendencies.

PLANT PATHOLOGY

854* CRONSHEY, J. F. H.

The Perfect Stage of *Botrytis squamosa* Walker.

Nature, Lond. 1946, **158**, 379.

The occurrence of apothecia in cultures of *Botrytis squamosa* is recorded. Single ascospore cultures were made and produced sclerotia and conidiophores typical of *B. squamosa*.

830* MARKHAM, R. & SMITH, K. M.

A New Crystalline Plant Virus.

Nature, Lond. 1946, **157**, 300.

A new virus disease is described for which the name turnip yellow mosaic is suggested. A method for purifying and crystallizing the virus is given. The virus crystallizes into small octahedra and the phosphorus and carbohydrate content are those of a nucleo-protein containing about 16 per cent. of nucleic acid of the ribose type.

831* SMITH, K. M.

Tobacco Rosette: A Complex Virus Disease.

Parasitology. 1946, **37**, 21-4.

An account is given of a composite virus disease of tobacco for which the name *tobacco rosette* has been suggested. The two component viruses, named the *mottle* and *vein-distorting* viruses respectively, have been separated, and their symptomatology and methods of transmission described. The mottle virus is both sap- and aphid-transmitted but the vein-distorting virus is aphid-borne only.

The symptoms and histopathology of the complex disease in the tobacco plant are dealt with in some detail. There are three main types of symptoms:—(1) intense rosetting, (2) splitting of the tissues, (3) formation of enations on the undersides of the leaves.

The splitting of the tissues has been examined microscopically, and a number of photomicrographs are given illustrating the formation of the fissures. It is suggested that there is a concentration of virus in the cambium which prevents the formation of the normal xylem. Abnormal tissue and giant cells are formed in the cortex and pith. This appears to set up stresses which cause the splitting.

The insect vector of the complex disease is the aphid *Myzus persicae* Sulz. Another aphid *M. pseudosolani* Theob. is also a vector but is less efficient than *M. persicae*.

859* SMITH, K. M.

Tomato Black Ring : A New Virus Disease.

Parasitology. 1946, **37**, 126-30.

A new virus disease of tomatoes is described, for which the name *tomato black-ring* is suggested. The host range of the virus is wide but no insect vector has yet been identified. The longevity *in vitro* of the virus is 7 days or longer, the thermal inactivation point is about 58°C. and the concentration of the virus in the host plant is low. Tomato black-ring is essentially a disease of young plants which rapidly lose their symptoms if they survive the severe initial infection. The virus is carried without symptoms by a large number of miscellaneous plants.

865* SMITH, K. M.

The Transmission of a Plant Virus Complex by Aphides.

Parasitology. 1946, **37**, 131-4.

An account is given of experiments on the aphid-transmission of the composite virus disease of tobacco known as rosette. It is shown that the component viruses—the vein-distorting and mottle viruses—persist for long periods in the body of the aphid, and that as many as twenty consecutive tobacco plants can be infected in 24 hr. serial transfers without the insect having recourse to a fresh source of virus.

The aphid *Myzus persicae* is the most efficient vector, the aphid *M. convolvuli* being less effective. The aphides *M. circumflexus* and *Macrosiphum gei* failed to transmit the virus.

It is shown that the mottle virus can only be transmitted by the aphid when it is accompanied in the plant by the other component of the rosette disease the vein-distorting virus. The latter virus is easily transmitted by the aphid, either alone or in combination with the mottle virus.

SMITH, K. M.

Virus Diseases of Farm and Garden Crops.

Littlebury, 1945. Pp. 111. Price 10s. 6d.

832* SMITH, K. M. & LEA, D. E.

The Transmission of Plant Viruses by Aphides.

Parasitology. 1946, **37**, 25-37.

Experiments are described on the transmission of mottle and vein-distorting viruses by aphides.

A quantitative analysis is made of Watson's experiments on the aphid transmission of persistent and non-persistent viruses. The principal features of the experimental results can be explained in terms of different rates of inactivation of the virus in the insect.

It is shown that these considerations explain why non-persistent viruses are more commonly sap-transmissible than persistent viruses.

860* SMITH, K. M. & MARKHAM, R.

An Insect Vector of the Turnip Yellow Mosaic Virus.

Nature, Lond. 1946, **158**, 417.

The insect vector of the turnip yellow mosaic virus has now been identified and found to be the turnip flea beetle *Phyllotreta cruciferae*. This is the first time such an insect has been shown to transmit a virus and the first case of a crystalline virus being insect-transmitted.

WESTON, W. A. R. D.

The Approval Scheme as seen by a Specialist Advisory Officer. Discussion of the Official Scheme for the Approval of Proprietary Products for the Control of Plant Pests and Diseases.

Ann. Appl. Biol. 1946, **33**, 241-2.

The author considers that the Approval Scheme in principle is one of the most significant advances yet made in agricultural and horticultural practice. He discusses the scheme in relation to the organo-mercury seed dressings. The approval scheme covers a wide range of products and the author considers that their fungicidal constituents and percentages should be stated on the container in order to enable the farmer to recognise identical products.

The efficiency of the different organo-mercury seed dressings is then discussed and it is shown by reference to field trials that some dressings are consistently better than others. The author suggests that products should be approved only after a field trial and the results of these trials should be published. He does not consider that the testing should be done by provincial advisers but by central testing stations.

849* WESTON, W. A. R. D., LOVELESS, A. R., & TAYLOR, R. E.

Clover Rot.

J. Agric. Sci. 1946, **36**, 18-28.

Clover Sickness caused by *Sclerotinia Trifoliorum* is widespread in America and Western Europe and in Britain it is important in East Anglia and Yorkshire owing to the severe financial losses it may cause. Most of the commonly grown legumes are susceptible. Peas, however, escape infection in the field but succumb to artificial inoculation. On the basis of pathogenicity there appears no valid reason for according varietal rank to the bean strain of *S. Trifoliorum* but retention of the name *S. Trifoliorum* var. *Fabae* is proposed until measurements have been made of ascospores from widely separated localities. Ascospores of both strains react identically on beans and clover. Apothecia may be produced from sclerotia buried in the soil at depths down to 2" and spore discharge may continue for 4 weeks.

The different methods are discussed by which the disease is spread. An examination of 1,000 diseased bean stems showed that in the haulm, sclerotia are formed most frequently between 2 and 7 inches above soil level, and many sclerotia may thus be harvested with the haulm and so find their way into the dung if the haulm is used for litter. An investigation of the viability of sclerotia in the dung of stock yards showed that they retained their viability up to 3 months under dry conditions but quickly lost it under wet conditions. Losses from the disease may be reduced by avoiding too frequent cropping with susceptible hosts, by the use of clean seed and sometimes by sheeping over-luxuriant crops. To prevent the spread of sclerotia it is suggested that infected bean haulms or clover hay should be used first so that it is incorporated in the lowest levels of the dung in the stock yard and the sclerotia thereby killed and subsequent spread prevented.

850* WESTON, W. A. R. D. & TAYLOR, R. E.

Seed Disinfection. VII. Mechanical Principles.

J. Agric. Sci. 1945, **35**, 239-42.

A comparison is made between machines of the rotational and gravitational types on the basis of evenness of mixing and the degree of disease control in the field. For the rotational machine a scale model was used.

Substantial control was obtained by both methods but the gravitational machine was not so efficient. The addition of a felt cone to the feed hopper resulted in an increase in efficiency. Using the model rotational machine to investigate the influence of number of turns on even mixing and assaying the results on the control of leaf spot of oats, it was found that as few as 48 turns gave an even mixing of grain and powder.

OTHER PAPERS

833* WESTON, W. A. R. D. **Apple Scab.** *Agriculture : J. Minist. Agric.* 1946, **52**, 551-3.

816* WESTON, W. A. R. D. **Bean Rot.** *Agriculture : J. Minist. Agric.* 1945, **52**, 425-6.

817* WESTON, W. A. R. D. **Potato Leaf Roll.** *Agriculture : J. Minist. Agric.* 1945, **52**, 365-7.

824* WESTON, W. A. R. D. **Powdery Mildew of Cereals.** *Agriculture : J. Minist. Agric.* 1946, **52**, 522-4.

PLANT PHYSIOLOGY

866* DARK, S. O. S. & BOOTH, V. H.

Total Carotenoids in Carrots.

J. Agric. Sci. 1946, **36**, 192-8.

During five autumns 238 samples of carrots comprising over seventy varieties were analysed for total carotenoids (t.c.).

The average t.c. value for common types (excluding certain very high value varieties and the almost colourless varieties) is 13.8 mg./100g. fresh carrot. Assuming 90% of the carotenoids to be "carotene" the average for the latter is 12.4 mg./100g. Negligible correlation is found between named variety and t.c. Red cored and small cored varieties are slightly richer than others. The pedigree of the seed is the most reliable indicator of probable t.c. content.

Six high t.c. varieties and a Red Cored Chantenay are described in detail. Four of them are of the long slim type with small red cores. One of them (Dippe's Surrey Long) has a mean t.c. value of 37.1 mg./100g. The high values have been further improved by selection in two subsequent generations.

829* HAWKES, J. G.

Potato 'Bolters': an Explanation Based on Photoperiodism.

Nature, Lond. 1946, **157**, 375.

It is shown that the 'bolter' condition of domestic potato varieties is due to a genetical alteration converting the plant from a long-day to a short-day type. Under short day length the bolter grows normally, but shows various wild characteristics under long days. This is paralleled by the behaviour of the short-day adapted *Solanum andigenum* when grown under a day length of 12 hours on the one hand and under the long summer days of temperate latitudes on the other.

OTHER PAPERS

RICHENS, R. H. **Relational Plant Morphology.** *Nature, Lond.* 1946, **157**, 127-8.

SOILS AND MANURES

855* CHILDS, E. C.

The Water-table, Equipotentials and Stream-lines in Drained Land. IV. Drainage of Foreign Water.

Soil Sci. 1946, **62**, 183-92.

This paper discusses the effect of drains intercepting ground water flowing downhill from an infinitely distant source. The drains considered are pipe drains and open ditches laid at various depths in land with different degrees of slope. With all pipes of ordinary size, the water table is controlled to pipe depth for slopes up to 1 in 30, but the control is less complete for a bed slope of 1 in 3. The capillary fringe, water table and streamlines are plotted in all cases.

OTHER PAPERS

842* HANLEY, F. **Soil Fertility as the Basis of Good Leys.** *Agriculture: J. Minist. Agric.* 1946, **53**, 116-19, 152-8.

NICHOLSON, H. H. **Land Drainage.** Contribution to *Farming Handbook No. 3*, pp. 26-38. Jarrold, 1945. Price 5s.

861* NICHOLSON, H. H. **Some Aspects of Field Drainage.** *Agric. Progr.* 1946, **20**, 65-9.

825* NICHOLSON, H. H. **Some Problems in Field Drainage.** *Scot. J. Agric.* 1946, **25**, 213-19

MISCELLANEOUS

ENGLEDOW, F. L.

Tea.

Chem. Ind. 1946, No. **23**, 220-1.

HIRSCH, G. P.

The Future of "Farming Clubs".

J. R. Agric. Soc. 1945, **106**, 95-114.

MANSFIELD, W. S.

Old Saws and Modern Knowledge. I-III.

City Life. 1945, **97**, 502-4, 510-12; **98**, 282-4.

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